was in advance of observation, at present observation is in advance of theory; which mathematicians are therefore called upon to remodel and perfect.

The author proceeds to consider the effect of the Moon's declination on the Tides at Liverpool; which, as before observed, it is necessary to eliminate, in order to obtain the Solar inequality; and gives an explanation of various formulæ and tables constructed for that object. He then investigates the laws of the solar inequalities, first, as to the heights; and secondly, as to the times of high water at Liverpool, by applying to them these methods of calculation.

March 10, 1836.

FRANCIS BAILY, Esq., Vice-President, and Treas., in the Chair.

Edward John Johnson, Esq., Commander, R.N., was elected a Fellow of the Society.

"Report of Magnetic Experiments tried on board an Iron Steam-Vessel, by order of the Right Hon. the Lords Commissioners of the Admiralty." By Edward J. Johnson, Esq., Commander, R.N., accompanied by plans of the vessel, and tables showing the horizontal deflection of the Magnetic Needle at different positions on board, together with the dip and magnetic intensity observed at those positions, and compared with that obtained on shore with the same instruments. Communicated by Captain Beaufort, R.N., F.R.S., Hydrographer to the Admiralty; by command of the Right Hon. the Lords Commissioners of the Admiralty.

This report commences with a description of the iron steam-vessel, the "Garryowen," belonging to the City of Dublin Steam Packet Company, and built by the Messrs. Laird, of Liverpool. She is constructed of malleable iron, is 281 tons burthen, and draws only $5\frac{1}{4}$ feet water, although the weight of iron in the hull, machinery, &c. is 180 tons.

This vessel was placed under the directions of the author, in Tarbert Bay, on the Shannon, on the 19th of October, 1835, for the purpose of investigating its local attractions on the compass. The methods which were adopted with that view are given; together with tables of the results of the several experiments, and plans of the various parts of the Garryowen. The horizontal deflections of the magnetic needle at different situations in the vessel were observed, for the purpose of ascertaining the most advantageous place for a steering compass, and also for the application of Professor Barlow's correcting plate: and the dip and intensity in these situations were, at the same time, noted.

An experiment is detailed, showing that where several magnetic needles, freely suspended, were placed upon the quay, in Tarbert Bay, and the vessel warped from the anchorage towards them, first with her head in that direction and then with her stern, opposite deflections were produced: in the first case all the needles showing a

deviation to the eastward, and in the latter to the westward, of the true magnetic meridian.

Considering the height of the general mass of iron in the vessel and also that of the head and stern, together with the distance (169 feet) at which some of the needles indicated a deviation, the author concludes that the respective deflections were caused by the magnetic influence of the iron in the vessel; the combined effect of that about the bows representing the north pole of a magnet, and that about the stern a south pole. He then offers several suggestions for future observation on this subject, and connected with the little oxidation that is reported to have taken place in the vessel.

The experiments having been interrupted by a continuance of wet and stormy weather, the author proceeds to draw the following general practical conclusions, deduced from the series of observations already made, and points out the further experiments which he considers necessary to be tried.

1st. The ordinary place for a steering-compass on board ship is not a proper position for it in an iron steam-vessel.

2nd. The binnacle-compass in its usual place on board the Garryowen is too much in error to be depended upon.

3rd. In selecting a proper position for a steering-compass on board iron steam-vessels, attention should be paid to its being placed, as far as is practicable, not only above the general mass of iron, but also above any smaller portions of iron that may be in its vicinity; or such portions of iron should be removed altogether.

4th. The steering-compass should never be placed on a level with the ends either of horizontal or of perpendicular bars of iron.

5th. The extreme ends of an iron vessel are unfavourable positions, in consequence of magnetic influences exerted in those situations. The centre of the vessel is also very objectionable, owing to the connecting rods, shafts, and other parts of the machinery belonging to the steam-engine and wheels, which are in continual motion; independently of the influence exerted by the great iron tunnel in this part of the ship.

6th. No favourable results were obtained by placing the compass either below the deck, or on a stage over the stern.

7th. It was found that at a position 20¼ feet above the quarter-deck, and at another 13¼ feet above the same level, and about one seventh the length of the vessel from the stern, the deflections of the horizontal needle were less than those which have been observed in some of His Majesty's ships.

The author proceeds to point out various methods of determining, by means of a more extended inquiry, whether the position above indicated, or one nearer to the deck, is that at which the steering-compass would be most advantageously placed.

The concluding section contains an account of some observations made by the author on the effects of local attraction on board different steam-boats, from which it appears that the influence of this cause of deviation is more considerable than has been generally ima-

gined; and he points out several precautions which should be observed in placing compasses on board such vessels.

"Researches on the Integral Calculus. Part I." By Henry Fox Talbot, Esq., F.R.S.

The author premises a brief historical sketch of the progress of discovery in this branch of analytical science. He observes that the first inventors of the integral calculus obtained the exact integration of a certain number of formulæ only; resolving them into a finite number of terms, involving algebraic, circular, or logarithmic quantities, and developing the integrals of others into infinite series. The first great improvement in this department of analysis was made by Fagnani, about the year 1714, by the discovery of a method of rectifying the differences of two arcs of a given biquadratic parabola, whose equation is $x^4 = y$. He published, subsequently, a variety of important theorems respecting the division into equal parts of the arcs of the lemniscate, and respecting the ellipse and hyperbola; in both of which he showed how two arcs may be determined, of which the difference is a known straight line. Further discoveries in the algebraic integration of differential equations of the fourth degree were made by Euler; and the inquiry was greatly extended by Legendre, who examined and classified the properties of elliptic integrals, and presented the results of his researches in a luminous and well-arranged theory. In the year 1828, Mr. Abel, of Christiana, in Norway, published a remarkable theorem, which gives the sum of a series of integrals of a more general form, and extending to higher powers than those in Euler's theorem; and furnishes a multitude of solutions for each particular case of the problem. Legendre, though at an advanced age, devoted a large portion of time to the verification of this important theorem, the truth of which he established upon the basis of the most rigorous demonstration. M. Poisson has, in a recent memoir, considered various forms of integrals which are not comprehended in Abel's formula.

The problem, to the solution of which the author has devoted the present paper, is of a more general nature than that of Abel. The integrals, to which the theorem of the latter refers, are those comprised in the general expression $\int \frac{P\,dx}{\sqrt{R}}$ where P and R are entire polynomials in x. Next in order of succession to these, there naturally presents itself the class of integrals whose general expression is $\int \frac{P\,dx}{\sqrt[3]{R}}$, where the polynomial R is affected with a cubic, instead of a quadratic radical; but Abel's theorem has no reference to these, and consequently affords no assistance in their solution. The same may be said of every succeeding class of integrals affected with roots of higher powers. Still less does the theorem enable us to find the sum of such integrals as $\int \phi\,(R)\,dx$; R being, as before, any entire polynomial (that is, containing at least two different powers of x),